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Anthony Mele
The University of Montana

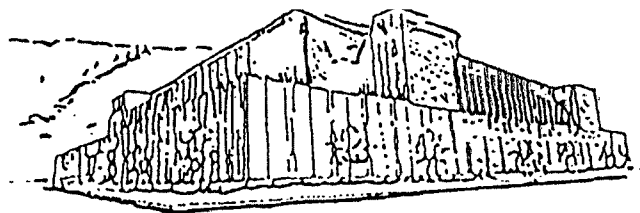
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An Analysis of the Effect of Environmental Science Education
on Student Attitudes


Presented in partial fulfillment of the
M.S. Degree requirements in
Environmental Studies,
University of Montana

1997

by
Anthony Mele

Approved by:


Chairman, Board of Examiners


Dean, Graduate School

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J.B.

Abstract

An Analysis of the Effect of Environmental Science Education
on Student Attitudes

by

Anthony Mele

This study assessed students who took a one semester environmental science course for changes in attitudes about the environment. A sample taken from a course included in the Systematic Teacher Excellence Preparation Project (S.T.E.P.) was evaluated prior to and following exposure to the semester treatment. The sample was tested to measure changes in environmental attitudes and the use of informational supports.

Results from the study show the course produced no statistically significant changes in attitudes, but did show significant increases in student use of informational supports ($p < 0.05$). Observational protocols and descriptive assessment techniques were used to characterize and evaluate course characteristics. The course was characterized as fitting within the parameters described in previous research defining environmental education. Results support previous research on affective and cognitive changes as a result of exposure to environmental education. Suggestions are made for further research and refinement of assessment techniques.

Contents

ACKNOWLEDGMENTS .	. iv
LIST OF FIGURES .	. v
LIST OF TABLES .	. vi
INTRODUCTION .	. 1
LITERATURE REVIEW .	. 2
METHODS	. 9
RESULTS	. 18
Classroom Learning Environment .	. 18
Attitude and Defensibility .	. 21
DISCUSSION .	. 21
Classroom Learning Environment .	. 22
Attitude and Defensibility .	. 24
CONCLUSION .	. 32
LIMITATIONS .	. 32
BIBLIOGRAPHY.	. 36
APPENDIX	. 39

Acknowledgments

I would like to gratefully acknowledge the patience, advice, and guidance of Dr. Fletcher Brown, Dr. Ralph Allen, and Dr. Hank Harrington. I could not have had a better combination of advisors. Throughout the process of research and writing they were always willing to lend comment and support to my efforts. Their questions enabled me to keep a clear perspective as well as a critical eye. Furthermore, they were flexible and accommodating during this process, enabling me to complete my work within what were often difficult time constraints.

I would like to offer a special thanks to Dr. Fletcher Brown. He has served as an advisor not only on this project but throughout my studies at the University of Montana, and beyond. He has been both a friend and an example, and I consider him a mentor in my field. His guidance has permitted me to pursue my goals as fellow explorer and teacher. I am truly indebted to him.

Finally, I would like to thank my wife Tara, who has patiently and diligently tolerated me while I undertook this project. Her love, support, and good-natured spirit, as well as her critical analysis, proved to be invaluable in producing this work. She deserves all my love and thanks.

List of Figures

FIGURE 1		
Linear Model of Behavioral Change Attributed to Increases in Knowledge	.	5
FIGURE 2		
Hines Model of Factors Influencing Environmental Behavior	.	8
FIGURE 3		
Equation for Determining Standard Lesson Score	.	12
FIGURE 4		
Laboratory Learning Profile from SLEI Data Analysis	.	41

List of Tables

TABLE 1	Goals for Curricula and Strategies in Mathematics and Science Teaching	Appendix
TABLE 2	Goals for Preservice Teacher Training	Appendix
TABLE 3	Examples of Inquiry Quotient Criterion and Questions	. 13
TABLE 4	Categories and Sample Questions from the Science Laboratory Environment Inventory	. 14
TABLE 5	Narrative from the EIADI - with supporting statement section	. 17
TABLE 6	Results from the Inquiry Quotient Assessment	. 19
TABLE 7	Results from the Science Laboratory Environment Inventory Questionnaire	. 20
TABLE 8	Comparisons of Pretest and Posttest Analysis of Attitudes, Total, Count, and Intensity Defensibility Mean Scores	. 21

An Analysis of the Effect of Environmental Science Education on Student Attitudes

Introduction

Environmental education has had a persistent identity crisis since the discipline began gaining notoriety during the birth of the environmental movement in the 1960's. This problem is reflected in the various names substituted for environmental education (EE); nature study, outdoor education, conservation study, and earth science, among others, are all included under the rubric of EE. While educators continue to debate about what EE is, some researchers claim this lack of focus has been an important contributor to continuing problems with ecological illiteracy (Weilbacher 1995; Hungerford, Volk 1990).

Since the 1970's educators have made great progress toward clarifying and defining the goals and objectives of environmental education. As environmental educators begin to identify common characteristics of the discipline, questions still remain regarding the effect on students' attitudes and knowledge about the environment. Given that environmentally responsible behavior has been identified as one of the primary purposes of EE (Ballantyne, Packer 1996; UNESCO 1977), it is arguably important to evaluate the methods used to effect attitudes. This study focused on one unresolved research area regarding EE: does environmental education influence student attitudes toward the environment? This research question has pertinence, particularly when one considers the previous research identifying attitudes as determinants of environmentally responsible behavior (Yount, Horton 1992; Kinsey, Wheatley 1984).

Literature Review

While the term “environmental education” may trace its roots back to the 1940’s, the discipline began developing recognition with the birth of the environmental movement of the late 1960’s and early 1970’s (Disinger 1985). Nature study, conservation education, outdoor education, population studies, and earth science all contributed to the evolution of a new, discrete entity commonly referred to as EE. While these curricula are now considered separate fields of study, they are still at times accepted as environmental education.

One of the early watershed events which helped focus educators on defining EE was the 1969 debut of the journal *Environmental Education*. Among other things, this event led to an international environmental symposium devoted exclusively to the task of classifying what EE should be. The 1977 Tbilisi Intergovernmental Conference on Environmental Education identified the goal for the discipline as the development of environmentally responsible behavior. The conference outlined 5 objectives which lead to this goal. These objectives were:

- Awareness
- Knowledge
- Attitudes
- Skills
- Participation

When condensed, Tbilisi defined EE as:

“...an approach to teaching and learning that will help students develop the knowledge, skills, and values basic to effective environmental problem solving. It is a process by which young people learn to take personal responsibility for their environments, develop broader perspectives, and

become involved in finding solutions to current and future environmental issues.”

(Beutler 1988)

Awareness was defined as developing a sensitivity toward the environment and environmental problems. The *knowledge* component incorporated understanding of ecological issues such as nutrient cycling, energy flows, and human impacts. *Attitudes* were identified as the values and behaviors that would guide a student’s behavior toward the environment. *Skills* training was included to assist students in effectively solving problems. Finally, *participation* was explained as the desire to act on these problems (Hungerford, Volk 1990; Beutler 1988). It is arguably the combination of these components (awareness, knowledge, attitudes, skills, and participation) which contribute to producing environmentally responsible behavior (Simmons 1991; Ramsey et al. 1989). Many educators and organizations have begun to accept this goal as a benchmark for the discipline, and much of the literature devoted to the subject supports this conclusion (Klein 1995; Simmons 1991; Hungerford, Volk 1990; Hines et al. 1987; UNESCO 1987; Stevenson 1993).

Nevertheless, there is far from a consensus on the subject of appropriate goals and methods for EE. For example, Simmons (1991) in her survey of nature and environmental education programs found not all respondents embraced the goal of fostering environmentally responsible behavior through addressing attitudes. She calculated that while nearly 80% of the programs surveyed reported they taught “environmental education”, only 48.9% identified components in their curricula that include some combination and examination of nature study/attitudes/and environmental behaviors.

Furthermore, programs disregarding these ingredients almost wholeheartedly abandoned other components of EE (skills training, action projects, etc.). For example, only 13.6% of respondents in this category considered disseminating information on local environmental issues a primary goal. These programs were apt to see themselves principally as providers of non-controversial information for their students.

“...some centers expressed concern over the need to be seen as an unbiased source of information...
...avoiding local environmental issues may be due to a concern over becoming involved with controversial issues:
‘We tiptoe around issues that have any political overtones’.
(Simmons 1991)

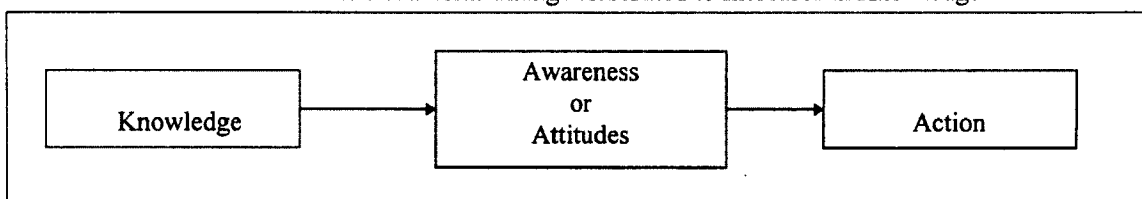
In spite of this lack of consensus, it is important to recognize that the dominant themes in environmental education literature support the objectives of Tbilisi (Stevenson 1993; Simmons 1991; UNESCO 1987). If we accept fostering responsible environmental behavior as the primary goal of EE, the next step environmental educators need to take is to examine what factors contribute to accomplishing this goal.

In the past researchers have focused on ecological knowledge as one of the principal contributors in establishing pro environmental behavior, and have studied the effect environmental education courses have on increasing student knowledge about the environment. Research indicates traditional methods (defined here as methods that rely exclusively on the dissemination of information, with little or no integration of other EE components) have little effect in increasing overall knowledge (Yount, Horton 1992; Iozzi 1989; Kinsey, Wheatley 1984; Ramsey, Rickson 1976; Cohen 1973). It has also been shown that increases made in content knowledge without the incorporation of some

degree of emotional involvement are soon lost, as the material is memorized but quickly forgotten (Yount, Horton 1992). Educators and curriculum planners, noting the inadequacies of a linear approach to the subject (See Figure 1) have called for a marriage of the information (or knowledge) segment with the remaining four components of the Tbilisi objectives (Weilbacher 1995; Niedermeyer 1992; Keen 1991). It has been suggested that in order to be more effective, educators must integrate knowledge with skills, participation, and attitude components into the curriculum of environmental education (Klein, 1995; Stevenson 1993; Roth 1988; Knapp 1983).

Figure 1

Linear Model of Behavioral Change Attributed to Increases in Knowledge



From Hungerford and Volk 1990

Researchers have also identified attitudes as a factor in the complex process of establishing positive environmental behaviors (Klein 1995; Leeming et al. 1993; Simmons 1991; Hungerford, Volk 1990; Hines 1984). Numerous variables have been identified as contributors to the development of attitudes, and in this case, attitudes toward the environment. Notable is the work detailing the correlation between cognitive developmental stages and student attitudes (Millar, Tesser 1989; Iozzi 1989). Yount and Horton (1992) argue that "...attitude is considered to be an interaction of cognitive, affective, and conative domains, all of which apply toward the attitude object in varying

degrees.” In their description, the cognitive component involves intellectual abilities and prior knowledge. The affective component refers to the degree of emotional attraction toward the subject or object. The conative component refers to behavioral tendencies toward the subject or object.

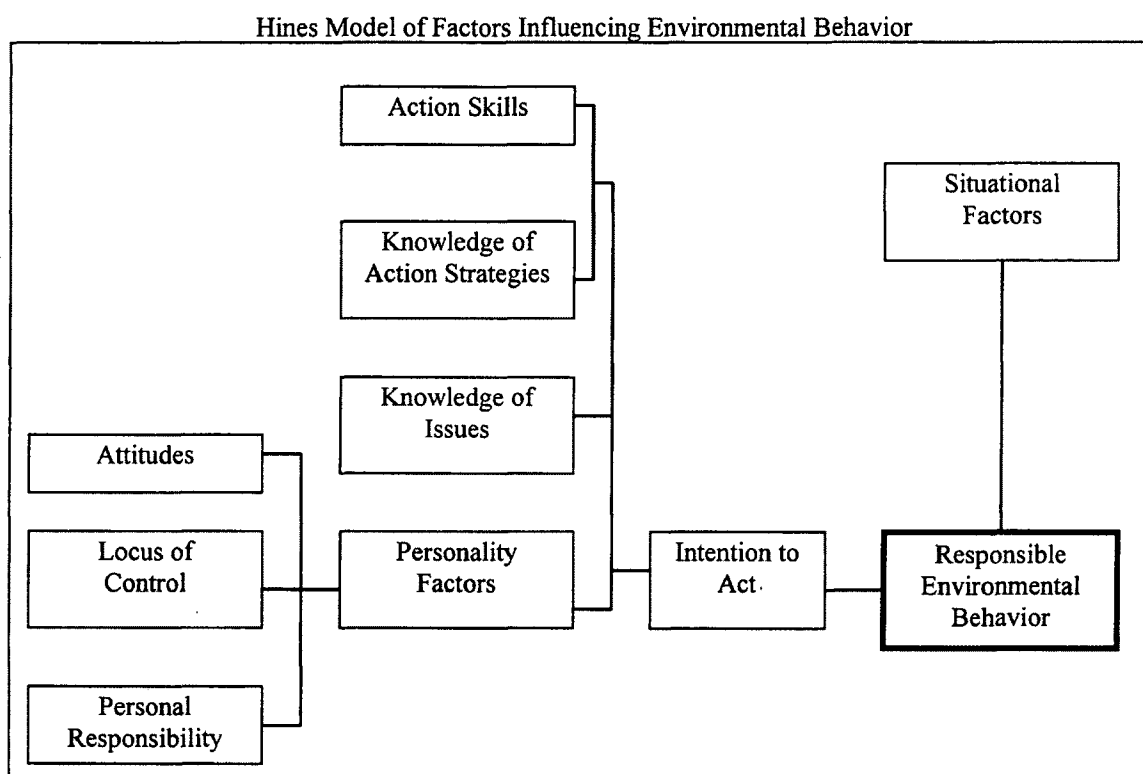
Learner development in relation to these factors may significantly influence student ability to assimilate information into his/her decision making process, subsequently affecting behavior (Iozzi 1989; Kinsey, Wheatley 1984). Yount and Horton point out that the ability of students to understand information and apply it appropriately in making relevant decisions may require reasoning and logic skills in the formal (or higher) stages. Consequently the role of cognition is important to recognize, as students who have not yet attained higher levels of development may have difficulty in environmental education courses which deal with relatively abstract concepts and relationships. Nevertheless, environmental education has been shown to be effective in promoting positive attitudes even at early ages (Bryant, Hungerford 1979); these effects should in part be credited to instructor recognition of student limitations and a tailoring of the material to suit the audience. This point is relevant, as some assessment techniques for environmental education may fail to make this recognition and adjustments.

What remains unclear is an evaluation of the effectiveness of the Tbilisi components in regards to affecting student attitudes about the environment (Leeming, et al. 1993; Roth 1980). Recent studies have provided mixed evidence regarding student attitude changes in EE learning environments. For example, Keen (1991) found students participating in the Sunship Earth program showed significant increases in their

understanding of ecological issues, but no significant change in attitudes about the environment. Klein (1995) and Yount and Horton (1992) found similar results in their studies of EE in geography curriculum and college environmental science courses. In a summary of studies focusing on knowledge and attitude changes after EE treatments, Leeming et al. (1993) found that out of 34 separate studies, 14 reported positive changes, 6 reported mixed results, and the remaining 14 reported either negative effects or were judged too unreliable in design to be considered credible.

For the purposes of this study, the primary focus was student attitudes, and more specifically, curriculum methods which promote positive attitudes about the environment. There is significant endorsement within the literature for using the methods outlined at Tbilisi in order to affect attitudes. For example, the Hines et al. (1987) outline of factors affecting attitude and subsequent behavior incorporates all the components recommended at Tbilisi (See Figure 2). Yet with few meaningful exceptions the pedagogy of EE courses has rarely been detailed in research. Reliable assessment of the outcomes of instructional methods would serve a valuable contribution to the discipline, though little work has been done in this area (Keen 1991; Iozzi 1989). One could argue that assessment of EE programs has often been based on an evaluation of diverse and possibly conflicting methods and objectives. The need remains to determine and define an effective pedagogy for EE before researchers can evaluate the overall impact of a particular program or the discipline in general.

Figure 2



From Hines et al. 1987

Given the previous review of literature, one of the notable research areas which has yet to be explored is whether environmental education, particularly courses that employ the Tbilisi components, significantly influence student attitudes. This study focused on this area of research using the following question as a guide:

Does an environmental science course incorporating international recommendations for EE change student attitudes about the environment?

Methods

Study Design

This study evaluated student attitude changes regarding environmental issues in a one semester environmental science college course. A pre and post test questionnaire was given to students to measure attitudes about the environment, and changes in those attitudes as a result of the course. The Environmental Issues Attitude Defensibility Inventory (EIADI) developed by Kinsey (1978) was chosen to gather data on attitudes and supporting information. To help characterize if the course modeled environmental education methods, two assessment tools were used. These tools included the Inquiry Quotient Analysis developed by Lawson (1976), and the Science Laboratory Environment Inventory designed by Fraser (1995). The method of analyzing attitudes mirrors past work, though research has mostly overlooked the need to characterizing learning environments to determine if course structure matched recommended methods for EE.

Sample Demographics

Demographic information was collected by examining the course roster and indicated the course was primarily composed of freshmen, sophomore, and junior preservice elementary education students (n +/- 75). Student demographics such as age, sex, educational background, and former exposure to EE were not quantified. No control group was accessible at the time of the study.

Treatment

The treatment in this study was a one semester environmental science course designed for pre-service elementary education majors. The course was modeled around the 5-E's learning cycle described by Trowbridge & Bybee (1990), as well as the techniques suggested for examining attitudes, values clarification, and action group projects described by Van Matre (1990). The course was structured around inquiry teaching methods. Each unit began with engagement activities designed to lead the students to a series of self developed questions. Laboratory sections allowed for exploration and further examination of these questions. Following laboratory explorations, lecture sessions provided terminology regarding concepts. In both the lecture and laboratory students were involved in activities which encouraged analysis of values and attitudes related to the various topics examined. Each student was required to examine a local environmental issue of his or her choosing and also to participate in a community action project. The topics in the course included:

Ecosystems

Water Resources

Air Resources

Toxic/Hazardous Substances

Biodiversity

Population Dynamics

Religion and Ethics

This course was developed under support from a 1993 National Science Foundation grant known as S.T.E.P., or the Systematic Teacher Excellence Preparation Project. The S.T.E.P. was a five year, six million dollar program under C.E.T.P.P., or

the Collaboration for Excellence in Teacher Preparation Program. The purpose of the grant was to provide funding for reforms in Mathematics and Science teaching, focusing specifically on preservice teacher training. The program relies heavily on engagement and inquiry techniques, social interaction, cooperative learning environments, and integration of diverse teaching styles as well as diverse cultural inputs when approaching math and science subjects. The goals for preservice teacher training stress practice, discussion, and reflection. The model includes areas for self evaluation, active teacher development, and practical, applicable focus when developing math and science curricula. The treatment course was developed recognizing and implementing these components and goals. Details of curriculum methods, strategies, and goals can be found in Tables 1 and 2 of the Appendix.

Measures

In this study the two factors measured were the classroom learning environment and students' environmental attitudes. The measures used for each factor are described below.

Classroom Learning Environment

To help characterize the learning environment it was necessary to first determine if the course utilized methods recommended at Tbilisi. Two discrete assessment tools were used in conjunction with personal observations in order to characterize the learning

environment; the Inquiry Quotient (I.Q.) designed by Lawson et al. (1976),¹ and the Science Laboratory Environment Inventory (SLEI) designed by Fraser (1995).

Inquiry Quotient. The Inquiry Quotient was used to determine the amount of inquiry teaching methods utilized in the classroom. The questionnaire assesses both teacher and student behavior. The I.Q. instrument is composed of twenty five questions separated into four subsections: The Lesson, Student Behavior, Teacher Behavior, and Questioning Techniques. The sections were scored and results compiled for a Standard Lesson Score (for scoring procedures see Figure 3). Four lecture sections were scored by an observer using the I.Q. checklist (see Table 3 for examples of I.Q. questions, and the Appendix for the complete I.Q. questionnaire).

Figure 3

Equation for determining Standard Lesson Score

$$\frac{\text{Total Criteria Score}}{\text{Number of Questions Answered}} \times \frac{25}{1} = \text{Standard Lesson Score}$$

If a question did not apply to the lesson, it was disregarded and the equation for evaluating the lesson score was adjusted. The scoring was broken down into four sub categories (Student Behavior, Teacher Behavior, Questioning Techniques, Lesson), then

¹ Not to be confused with the Intelligence Quotient assessment.

condensed and taken as a general score on inquiry methods for the lesson. The scores for each lesson were averaged for a total Inquiry Quotient score for the course.

While the instrument was primarily designed as a measure of inquiry techniques, the factors evaluated can also be indicators of EE's objectives. For example, question #1 relates to awareness and motivation components. Questions #2 and #3 relate to values clarification provisions within the lesson. Question #5, as well as #8 through #10 relate to awareness and knowledge components, and question #11 refers to the issues of knowledge and values. Inquiry techniques are indicators of a pedagogy which stresses student participation, sensitivity, knowledge, and evaluation of attitudes and values, and are strongly endorsed within environmental education literature (Ramsey et al. 1992; Iozzi, 1989; Lawson et al. 1976).

Table 3

Examples of I. Q. Criterion and Questions

The Lesson	Student Behavior	Teacher Behavior	Questioning Techniques
Materials and activities which provoke thinking, questioning, and discussion	Students formulating and testing hypothesis, models, or predictions	Acts as a classroom secretary when data need to be organized	Majority of teacher questions are divergent
Provisions within the lesson for a variety of levels and paths of investigation	Students analyzing, interpreting, and evaluating data	Concepts introduced after direct experiences	Individuals called upon after questions are asked
Lesson involves fundamental concepts of the discipline	Class conclusions based on evidence	Opportunities for extending concept meaning provided	Responds to questions by providing additional ideas, information, or clues to extend student thinking

Science Laboratory Environment Inventory. The Science Laboratory

Environment Inventory (SLEI) was utilized to characterize student perceptions about the learning environment within the laboratory. The test is composed of thirty five questions regarding lessons, techniques, and laboratory environments. The questionnaire is scored on a scale of 1 to 5. A score of 1 indicates the practice took place “Almost Never”, while a score of 5 indicates the practice took place “Very Often”. Each question is used as a measure of a particular characteristic of the science laboratory learning environment (see Table 4). Mean scores for each category were calculated to assist in evaluating student perceptions. This tool, like the I. Q. instrument, was helpful in determining if characteristics common to inquiry methods were present in the laboratory (see the Appendix for a complete SLEI Assessment Test).

Table 4

Categories and Sample Questions from the Science Laboratory Environment Inventory	
Category	Question
Openendedness (OE) <i>Lessons composed of varying paths of investigation and instruction</i>	There is opportunity for students to pursue their own science interests in the laboratory
Rule Clarity (RC) <i>Procedures and expectations are clear</i>	The laboratory class has clear rules to guide student activities
Integration (IN) <i>Lecture and laboratory learning environments/materials complement each other</i>	The laboratory work is related to the topics we cover in lecture
Student Cohesiveness (SC) <i>Students/groups situations are conducive to learning</i>	Students work cooperatively in the laboratory
Material Environment (ME) <i>Materials/laboratory equipment and environments are helpful and of good quality</i>	Equipment and materials that students need for laboratory activities are readily available

Attitude and Defensibility

Previous research studies have consisted of different techniques to assess attitudes; Klein (1995) scored attitudes based on personal interviews; Keen (1991) employed a pre/post test questionnaire consisting of value statements (e.g. “Learning about nature is interesting”); Jaus (1984) employed a pre/post test questionnaire scored on a Likert scale; Carpenter (1981) designed a questionnaire around the Guttman Scalogram procedure (students “agree” or “disagree” with a set of statements which range in degrees from “least positive” to “most positive”). Yount and Horton (1991), and Kinsey and Wheatley (1984) employed an assessment tool designed by Kinsey in 1978, the Environmental Issues Attitude Defensibility Inventory (EIADI). The test, scored on a Likert scale, allows researchers to evaluate both environmental attitudes and informational supports affecting those attitudes. It was developed in recognition of the complex nature of attitude, value formation, and the relationship knowledge has toward influencing attitudes. In applying this tool, both research teams found increases in informational supports used to defend environmental decisions, but no significant shifts in attitudes. The EIADI was the primary measure used in this study.

Change in student attitude was assessed using a pre and post semester administration of the Environmental Issues Attitude Defensibility Inventory (EIADI). The test presents students with four environmental narratives, a proposed plan of action, and a set of options students can choose related to the plan of action. The options, or value judgments, are scored on a Likert scale of 1 to 4, corresponding to a gradient of “non-environmental” to “pro-environmental”. Students are required to take a position, as there

action” option or neutral position. The option chosen is considered a measure of student attitudes toward each particular issue. Mean scores below 2.0 are considered a reflection of negative or “non-environmental” positions, while scores above 2.0 are interpreted as “pro-environmental” (Kinsey, Wheatley 1980). Narrative issues included Food and Populations, Habitat Destruction/Diversity-Stability, Pesticides and the Environment, and Land Use and Development.

Each narrative also presents twelve related statements for students to use as supports when making their decisions, indicating their position for each statement on a scale of 1 to 5, with 1 indicating the statement was of “great importance to my decision” and 5 indicating the statement was “of no importance to my decision” (See the Appendix for the complete EIADI questionnaire). The informational supports chosen and the importance assigned to each are used as a measure of the “defensibility” of student decisions. For the purpose of scoring, the values students assign to each statement are reversed; for example, 1,2,3,4,5 becomes 4,3,2,1,0 in order to reflect the nature of the choice. A choice of 5 on a supporting statement indicates the statement had “no importance to my decision” and is recorded as a zero value when scored. Additionally, seven false statements are interspersed within the forty eight total supports, and are used to mitigate the effect of students padding their scores if they randomly assign weight to statements. Scores on the seven false positives are re-reversed, lowering overall scores on the supporting statement section. An example of one of the environmental scenarios, including supporting statements, follows in Table 5.

Table 5

Narrative from the EIADI Assessment, with Supporting Statement Section

<p>Dr. Alexi Pokrovsky is the head of regional planning in the Ukraine area of the Soviet Union. A wilderness lake several hundred miles long and about fifty miles wide is located in his district. Averaging approximately thirty meters in depth, it is very similar in geomorphology to Lake Erie. At the present time there is an abundance of high quality fish in the lake. This lake is being considered for the development of an experimental nearly self-sufficient urban area. This plan includes using the rich upstream area for industrial farming, exploration of the fishing industry and also urbanization of the southern shore. The plan would be of obvious economic benefit to the area, but Dr. Pokrovsky is also concerned with the effects on the lake.</p> <p>What action should Dr. Pokrovsky take?</p> <ul style="list-style-type: none"> (1) Enact the plan without reservation (2) Enact the plan with reservation (3) Discard the plan with reservation (4) Discard the plan without reservation <p>Before you turn the page, please think through what facts, concepts, and/or alternatives you considered in making your decision.</p>	<p>Use the following scale to indicate the importance of each consideration to your decision:</p> <ul style="list-style-type: none"> (1) Of great importance to my decision (2) Of much importance to my decision (3) Of some importance to my decision (4) Of little importance to my decision (5) Of no importance to my decision <p>Remember, do not assume that the considerations are true. Mark '5' if you believe the statement to be false or not accurate.</p> <ol style="list-style-type: none"> 1. Fertilizer from the farming operation would artificially add nutrients to the lake and increase the rate of eutrophication. 2. Temperature increases could contribute to an increase in oxygen levels. 3. The long term succession of a lake will lead to a filling in of the basin by continual siltation. 4. Phytoplankton "blooms" tend to deplete the oxygen levels. 5. A lake this size has the power to cleanse itself and, therefore, man can have only minimal effect on it. 6. Engineering procedures exist whereby sludge can be removed, benthic fauna can be cleansed, toxins can be precipitated out of the ecosystem; and all at a reasonable expense. 7. Domestic sewage can artificially add nutrients to the lake and increase the rate of eutrophication. 8. Toxins which may be introduced as industrial waste can accumulate in the food chain. 9. Domestic sewage can increase the bacterial levels in the lake. 10. Eutrophication is a slow natural process where nutrients increase and change the character of the ecosystem of a lake. 11. Over-fishing could "cause" a shift in the abundance of desirable fish because of the increased pressure from an effective predator – humans. 12. Location of the farms in a down-stream area could lessen the effects on the lake.
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The narrative allows for a measurement of student attitudes towards the environmental issue. The supporting statement section allows for a measurement of the information used to make the decisions (“defensibility”) and indicates knowledge gains made during the semester. The four categories related to attitude and defensibility that were measured were Attitude, Total defensibility, Count defensibility, and Intensity defensibility. At this point in time it remains unclear as to which of the three measures of defensibility, or which combination, most accurately characterizes the defensibility of student decisions.

Measures of Attitude and Defensibility

Attitude - a measure of the mean score of the four options chosen relating the environmental scenarios, with 4.0 as the maximum possible mean score.

Total - a measure of the sum of the weights given to the supporting statements, with 192 as the maximum possible mean score.

Count - a measure of the number of supporting statements students have taken into consideration regardless of the importance they assigned to each. The maximum score possible was 48.

Intensity - a measure of total divided by count. A 4.0 score was the maximum possible mean value.

Results

Classroom Learning Environment

The learning environment was characterized using two descriptive assessment tools, the Inquiry Quotient and the Science Laboratory Environment Inventory, in

conjunction with personal observations. Lectures and laboratory lessons were attended on a regular basis and observed. Results for the Inquiry Quotient analysis indicate high mean totals for the four lessons scored (see Table 6 for Standard Lesson Scores and the overall mean I.Q. score). The overall mean Inquiry Quotient score, determined by computing the average of the four Standard Lesson Scores, was 85.05.

Table 6

Criteria	The Lesson	Results from Inquiry Quotient Assessment				Total Score
		Student Behavior	Teacher Behavior	Questioning Techniques	Number of Questions Scored	
Maximum Possible Score	28	16	24	32		
Observed Score	22.45	13.2	17.0	26.3	24	82.2
	24.65	11.85	22.25	26.45	25	85.2
	24.5	12.4	22.75	27.3	25	86.9
	23.2	12.7	22.75	27.3	25	85.9
Average	23.7	12.5	21.2	26.8		85.05

When broken down by category, the mean score for The Lesson was 23.7 out of a possible 28.0 score. The mean for Student Behavior was 12.5 out of a possible 16.0 score. The mean for Teacher Behavior was 21.2 out of a possible 24.0 score. The mean for Questioning Techniques was 26.8 out of a possible 32.0 score.

A further evaluation of the learning environment was accomplished using the Science Laboratory Environment Inventory (SLEI). This questionnaire was distributed during the last week of the semester. As in the I.Q. assessment, scoring can be further broken down into categories. Mean scores in each of the five categories were calculated

by determining the sum of the values indicated, dividing by the number of questions in each category (7), and again dividing by total number of students responding ($n = 45$).

These results are reported in Table 7.

Table 7

Results from SLEI Questionnaire		
($n = 45$)	Total Score	Mean Score
Student Cohesiveness (SC)	1108	3.52
Open Endedness (OE)	1107	3.51
Integration of Material (IN)	841	2.69
Rule Clarity (RC)	916	2.91
Material Environment (ME)	742	2.36
Mean Score for all Categories		3.00

Results from the SLEI can also be tabulated in graph form to create a profile of the learning environment. Possible scores for each category range from 1.00 to 5.00, with scores above the median of 3.00 indicating positive student reactions to the category. When evaluated individually, the categories of Student Cohesiveness, Open Endedness, and Rule Clarity all scored above or close to the median of 3.00. The categories of Topic Integration and Material Environment scored below the median. When combined, the average mean score for all categories is 3.00. See Figure 4 in the Appendix for the SLEI learning profile.

Attitudes and Defensibility

Attitudes were assessed using the EAIDI questionnaire designed by Kinsey (1978). Pretest and posttest semester scores for attitudes and defensibility were calculated using paired *t*-test comparisons to determine if statistically significant changes had occurred in attitudes and the use of informational supports. The data indicated no statistically significant changes had occurred in attitudes as a result of the treatment course (see Table 8). Statistically significant improvements were indicated in pre to post semester scores for defensibility in the categories of Total Defensibility (the sum of weights given to all considerations) and Count Defensibility (the number of statements taken into consideration). No significant changes were indicated in Intensity Defensibility scores. See Table 8 for a complete data summary.

Table 8

Comparisons of Pretest and Posttest Analysis of Attitude, Total, Count, and Intensity
Defensibility Mean Scores

Parameters	Pre-Semester	Post-Semester	<i>t</i> value	<i>p</i> value
Attitude	2.735	2.742	-0.111	.913
Total defensibility	119.455	128.636	-3.563	.001*
Count defensibility	37.061	40.909	-3.662	.001*
Intensity	3.562	3.233	1.164	.253

* $p < 0.05$

Discussion

The goal of environmental education is to help students develop the knowledge, skills, values, and motivations necessary to confront and solve environmental problems. This study has focused on attitude changes, and the contribution those changes have in the development of environmentally responsible citizens. For the purposes of this study

the objectives outlined in Tbilisi were accepted as the benchmarks for environmental education, and used to evaluate the learning environment for the course. While the primary concern was the effectiveness of EE in influencing attitudes, the analysis of the learning environment was necessary to identify the presence of the five objective study areas for the discipline. Much of the previous work evaluating EE has failed to define course methods, perhaps offering an explanation for poor results and bringing into question what has actually been evaluated.

Classroom Learning Environment

The syllabus for the course studied identified goals and objectives for the semester. The stated goals and objectives agreed well with those described in Tbilisi and the literature on EE. Examples of course goals included:

“...to give students a conceptual understanding of the complexity of environmental science...
 ...to show how population, pollution, and resource problems are interrelated and must be understood in an integrated manner on local, national, and global scales...
 ...to develop skills in environmental problem solving; gathering, analyzing, synthesizing and interpreting information, and joint critical decisions making...
 ...to provide opportunities to apply acquired knowledge to an environmental problem that students have identified and recognized as important...
 ...to substitute feelings of apathy and powerlessness with the feeling that one individual or group can make a difference.”

Analysis of learning environments, beginning with the I.Q. assessment, indicated the course was based on a strong foundation of inquiry techniques (see Table 4). These

data also match well with researcher observations throughout the semester, indicating the course was structured around methods incorporating knowledge, values, skills, and action components. Each unit began with an engagement activity followed by elaboration segments designed to assist students in incorporating concepts. Laboratory sections dealt extensively with issue analysis, values clarification, and skills training, while lecture provided information and concept knowledge. The I.Q. analysis indicated high average scores in all categories, and an overall mean score of 85 out of a possible 100.

Data from the Science Laboratory Environment Assessment resulted in a learning profile for the course which showed above average or average mean scores for the factors of Student Cohesiveness, Open Endedness, and Rule Clarity (see Figure 4). Below average scores were found for Integration and Material Environments. These results match well with researcher observations and student comments throughout the term of the course. The results characterize a learning environment where students worked well with each other and had many opportunities to interact, lessons allowed for varying and diverse paths of investigation, and rules and expectations were clearly understood. Course topics though did not always seem to complement each other between lecture and lab sessions, and students were not satisfied with the laboratory rooms and/or the materials provided for laboratory activities. Scores from these latter categories dropped the combined average below the positive range on the scale. Overall mean scores for the five combined categories were 3.00 out of a possible 5.0, indicating average overall impressions on the SLEI categories (see Table 7 for mean scores in all categories).

These data support information gathered from the I.Q. assessment and researcher observations concluding that the course was primarily structured around inquiry methods. Contemporary literature on the subject of environmental education, as well as the S.T.E.P. objectives, support the use of inquiry techniques. Inquiry methods alone though do not automatically translate into a comprehensive environmental education program. Nevertheless, the lessons addressed relevant issues (*awareness*), examined values and attitudes (*values clarification*), presented relevant information (*knowledge*), taught methods for addressing problems (*skills*), and required students to incorporate information into some form of action or community project (*action*). An evaluation of course objectives, topics, methods, and data from the I.Q. and SLEI assessments, along with researcher observations, make it reasonable to conclude that the course incorporated environmental issues in a format which fit well under the benchmarks of environmental education, and the S.T.E.P. objectives.

Attitude and Defensibility

The Environmental Issues Attitude Defensibility Inventory allows for a measurement of attitude changes as a result of exposure to the treatment. Additionally, the ELADI measured student assimilation of information, reflected in defensibility scores (see Table 8).

The treatment resulted in no statistically significant changes in attitudes. It is reasonable to conclude that this result is not attributable to a failure to implement the recommended pedagogy for EE, as the course was characterized as fitting well within the

accepted definition. Though a short, intensive course examining locally pertinent issues may be expected to cause attitudes to shift in some measurable way, these data support previous research indicating short term exposure to environmental education has no significant effect in changing attitudes (Klein 1995; Keen 1991; Yount, Horton 1992; Kinsey, Wheatley 1984).

Results did show statistically significant gains in Count and Total defensibility. This indicates students increased the number of supporting statements used, and the importance those statements played in making their choices. The ramification is that students have gained knowledge from the course and are applying that knowledge in their decision making processes. These results support conclusions from previous research indicating short term EE treatments do not affect attitudes, but do increase the application of content knowledge (Klein 1995; Yount, Horton 1992; Kinsey, Wheatley 1984). No significant changes were seen for the category of Intensity, which is a measure of Total divided by Count (See pg. 19). This result is consistent with pervious study results, and lends evidence that the Intensity variable is a less accurate and reliable factor in measuring defensibility.

Results from the defensibility factors indicate that after exposure to an environmental education learning environment, students use greater informational supports on which to base their value decisions. This increase in informational supports indicates student decisions were made based on an increase in understanding, and suggests students are relying less on emotional factors than was the case in the pre-semester evaluation (Yount, Horton 1992). It is reasonable to credit these results to an

effective methodology which shows potential for obtaining EE's goal of developing responsible environmental citizens, and can be considered a positive result, despite the lack of improvement in attitude scores.

An analysis of the data does not support the position that this institutional approach improves attitudes about the environment. Nevertheless, when attempting to evaluate student attitudes it is important to recognize that results may be influenced by the amount of time devoted to the subject and the pedagogical approach students encounter. This claim is strongly supported in the literature by environmental educators who recommend infusing EE into the full range of curriculum studies. Environmental education should begin early in the educational process and proceed throughout grade levels in order to result in positive attitude gains toward the environment (Weilbacher 1995; Klein 1995; Ramsey et al. 1992; Keen 1991; Iozzi 1989). This approach would mirror teaching approaches in Math, Science, English, and other disciplines. Environmental education, on the other hand, is just beginning to gain prominence as a credible and substantive discipline. With a few notable exceptions, in many public school systems the reality is that most students receive only brief, rudimentary environmental education experiences (Hungerford, Volk 1990).

It is possible that the recommended pedagogy is ineffective, in the long term, in affecting attitudes. Considering the lack of reliable long term assessments which include a characterization of learning environments, it would be premature to make this evaluation. This study along with previous results support these methods for EE, given the limitations of the research, and researcher experience further supports these conclusions. The next

necessary step is a long term analysis of attitudes in students exposed to a full range of systematic environmental education experiences (Weilbacher 1995; Hungerford, Volk 1990; Iozzi 1989). These type of evaluations would provide a more reliable indicator of the effectiveness of EE, and the objectives outlined in the S.T.E.P. program.

The qualitative nature of attitudes necessitates assessment tools that are designed to be sensitive enough to measure subtle changes. It may not be reasonable to expect one tool to be applicable across samples. While the Environmental Issues Attitude Defensibility Inventory may be appropriate for students at higher cognitive stages, its usefulness is limited with younger students (Yount, Horton 1992). The design of the tool could still be applicable with younger populations, though the narratives should be tailored to the target audience. Furthermore, future evaluations should identify and define program methods and objectives and compare them with the stated goals of objectives for EE. Matching program goals with EE's goals is an essential step in the process of accurately measuring program effectiveness. If the intention of a program is primarily to increase knowledge, assessment tools focused primarily on attitudes will be inadequate in measuring outcomes.

It may also be argued that using attitudes as an assessment measure may be unreliable. Tbilisi clearly defines the development of environmentally responsible citizens as the primary goal of EE, but it does not necessarily follow that positive environmental attitudes are the only or most significant determinant of responsible behavior. While attitudes play a definitive role in the development of behavior, it may be more realistic and even desirable to focus on the establishment of a citizenry that makes

informed and defensible environmental decisions based on reliable and pertinent information. The focus here shifts from developing “pro-environmental” citizens to critical, fully informed citizens. While there is no denying that environmental educators would like to see positive environmental attitudes result from their courses, it is shortsighted to disregard the importance of informational gains which may affect the decision making process. Decisions based on fact and knowledge rather than emotion or hearsay are indicative, on their own merit, of a responsible citizenry.

The debate continues regarding appropriate methods and goals for the discipline. One need only review the literature to discern that while curriculum planners, educators, and school boards are beginning to recognize the need for environmental education, no genuine consensus exists on how to approach it, and few effective, systematic programs are available (Ramsey et al. 1992). Discussions with educators through the course of the study revealed a multitude of approaches. While this diversity in methods may actually be positive, the crucial issue apparent in these conversations was the inconsistent goals educators held for their courses, and the discipline in general. While some felt addressing attitudes and values in conjunction with information and skills training was a perfectly appropriate method for developing responsible citizens, others expressed a concern that these same methods and goals were unsuitable, and possibly even unethical.

In light of the results of this study it may be reasonable to question the necessity for a “values clarification” component in EE, especially when considered with the controversy which surrounds the subject. When evaluating this position, one must first recognize two relevant points: a) this study, as well as most of the research on outcomes

for EE, are short term evaluations examining short term EE exposures, and b) research indicates that environmental education in the absence of values clarification components results in little retention of knowledge, and no change in attitudes (Yount, Horton 1992). The first point may explain the lack of significant shifts in attitudes. The latter argument suggests that EE may be even more ineffective if stripped of the values component. Both should be examined in the context of the need for a subtle shift in outcome assessment, as was argued for previously in this paper. If we accept that responsible citizens are in part those that make informed, “defensible” decisions, and we recognize that examining values in EE contributes on some level to increased knowledge gains, it follows that the component is valuable to the discipline.

A problem arises when we consider the cost of such an approach. Inclusion of a “values clarification” component often invites misunderstanding and controversy from parents, communities, and administrators. It has been suggested that the discipline would do well simply to abandon the component altogether, or at the very least rename it to something less provocative. This “Trojan Horse” approach, while saving educators the trouble of explaining or defending their methods, runs the risk of also compromising the integrity of the lesson itself.

What seems to be at issue here is a matter of credibility. We educators need to clearly define and explain our pedagogical approach, yet the line that we walk is one balancing the urgency environmental educators feel for the subject with the reality of most public school curricula priorities. While lip service is often paid to the virtues of environmental education, the truth remains that attendance, literacy rates, and test scores

dominate the discourse on education today. And while arguably no education is “value free”, attempting to address environmental issues which are by their very nature framed and defined by diverse value systems may be increasingly difficult given the constraints of a “value free” curriculum.

The answer to the dilemma probably lies somewhere within the extremes. In order to continue to move toward recognition as a credible approach to teaching, environmental educators must first recognize that the current research does not lend support to this pedagogy as a reliable means of influencing attitudes. Nevertheless, this method does show knowledge gains. These gains are a worthy measure of usefulness as well as a definitive step toward achieving the goal of developing a responsible citizenry. The key here lies in recognizing and promising only what we are sure we can deliver at this time. It may be unrealistic to expect short term, intermittent environmental education approaches to result in a citizen that exhibits all the qualities Beutler defined on page 2 of this paper. Yet while it is true that the outcomes of the Tbilisi methods have been mixed to this point, these results can still be seen as positive when viewed in light of the research on other instructional techniques for the discipline. Regardless of the name given to it, “Values Clarification” is an essential component of environmental education, providing an essential tool for thorough investigation of the issues and a method for establishing the relevance of the subject in students’ lives.

Confusion persists over exactly what “values clarification” really means, and at what point it should be approached in the educational experience. Some view it as simply a means for students to assess and define their own priorities, while others see it as a

method of actually imposing values. The actual intention is relatively clear upon reviewing literature on the subject. Environmental Education strives to assist students in identifying and examining their own values toward environmental issues, and encourages discovery and exploration of alternative ideologies. It is through this type of exploration that students will develop informed and assured attitudes about environmental issues. Establishing comprehensive, long term EE programs will remain difficult as long as misunderstanding remains regarding this essential aspect of the discipline. Nevertheless, environmental education without the combination of knowledge, values clarification, skills, and action is not really environmental education.

Conclusions from any research must at some point take into account that environmental education is often a singular event in the educational experience. It is unrealistic to expect one day, one week, or even one semester of the best of environmental education to have significant impact on attitudes formed over years. A complete environmental education program should be incorporated systematically into a broad range of educational experiences if we truly desire to develop environmentally aware and responsible citizens capable of confronting relevant issues within their communities and beyond, with the skills and motivation to produce dynamic solutions. Simmons (1991) says it best when she argues that people cannot be expected to act responsibly if they have not been provided with the appropriate tools. The Tbilisi objectives for environmental education provides these tools in a structure that is effective at developing students with moderate environmental positions that are informed and defensible.

Conclusion

Descriptive assessment tools allowed for a characterization of the learning environment which showed the course assessed matched well with the suggested objectives for EE, and those of S.T.E.P. The results from the assessment of attitudes showed that students did not change their attitudes toward the environment after exposure to the treatment course. Students did increase the amount of information used in making environmental decisions, indicating the course did have an effect on the assimilation of knowledge.

The ultimate goal of EE is the development of environmentally responsible citizens. While the use of a model environmental education learning environment did not affect student attitudes, the increases seen in the knowledge component support incorporation of the pedagogy in addressing environmental issues and attaining at least partial fulfillment of the goal of EE. Further research is needed to determine if the incorporation of the five Tbilisi objectives in a systematic environmental education program has any significant effect on attitudes. This research should identify program goals and methods, match these to EE, and follow students exposed to a curriculum which employs these methods over time.

Limitations

Values, and to a lesser degree, attitudes about the environment, are by their nature controversial topics that do not always lend themselves well to quantitative analysis.

Shifts in attitudes may be subtle, slow to develop, and require measurement techniques that are not only sensitive, but also mindful of the delicate nature of the discourse on values clarification and attitudes. The controversy which surrounds values clarification often serves to cloud assessment of methods and outcomes.

This study was designed to remain focused on one issue: attitude changes attributable to environmental education. Numerous variables contributing to attitude formation were not included in the evaluation, limiting the ability of this study to make definitive claims as to the influence of the criteria measured. Student development in the realm of cognitive reasoning ability is the most significant of these excluded variables.

→ [No control group was available at the time of the study. Sample size was relatively small, the test group was not randomly chosen, and few student demographics were collected. These limitations should be considered when attempting to generalize the results to a wider population.]

There has been little research into the long term effects of environmental education on attitudes. The body of work focuses on treatments ranging from a few hours to a typical school semester in duration. This study mimics the common method of evaluating attitudes immediately following the treatment, as it was not possible to follow the sample subsequent to the semester. Follow up evaluations would contribute to the credibility of research conclusions.

A further limitation may be found in an analysis of the assessment tool measuring attitudes and defensibility. The tool (EIADI) presents students with four environmental

scenarios which may not be sensitive enough to measure attitude shifts, or which may not provide enough options to reflect changes (See Appendix for the EIADI scenarios and options). It is possible that students had changed their positions through the course of the semester, yet the options available did not offer a great enough range to measure shifts in attitudes. The data indicated information used to choose the options had increased, so it may be possible that by providing a more sensitive measure or range of options attitude shifts might also be detected.

Researchers tend to strive for general assessment tools which are applicable with a wide range of groups. This approach may not be the most effective assessment method considering the literature on cognitive reasoning clearly indicates the level of development has a significant effect on a students' ability to absorb, understand, and assimilate information into the problem solving process (Iozzi 1989; Kinsey, Wheatley 1984; Jaus 1984). This limitation is apparent in an assessment tool requiring formal reasoning abilities. The four environmental scenarios presented to test takers are general stories requiring a decision, but which one could argue are only marginally applicable to course content. Expecting students to relate the general situations presented in the EIADI to specific, local issues addressed in the treatment course presumes students have achieved high enough cognitive reasoning levels to relate the abstract dilemmas to concrete local examples. Students may or may not have achieved these levels of cognitive abilities. A more effective technique might be to employ the basic structure of the EIADI, but specialize the scenarios so that they apply to local issues addressed in the course. This would allow researchers to determine if attitudes have changed toward specific and

relevant issues students are faced with, and would partially eliminate the limitations of the tool in regards to cognitive levels and the abstract nature of the scenarios currently presented.

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Appendix

S.T.E.P. Goals for Curricula and Strategies

Table 1

Goals for the use of Curricula and Strategies in Mathematics and Science Teaching

Table 1 (from S.T.E.P.)

Mathematics and Science Teaching Framework for Career Preparation and Support Component

1. Use of curricula that show the uniqueness of various areas of mathematics and science, but which also illustrate relationships between (a) subdisciplines within mathematics; (b) subdisciplines within science; (c) mathematics and science; and (d) mathematics or science and other subject areas, such as social studies or reading / language arts.
2. Active engagement of students in inquiry, problem solving, and model building.
3. Progression in learning from concrete to abstract, including ample opportunities to work with manipulables and hands-on materials.
4. Regular opportunities for social interaction and group work.
5. Strategies to determine and build upon students' preexisting ideas.
6. Real word applications of mathematics and science.
7. Appropriate uses of technology, including graphing calculators, individual computers and computer networks, laboratory interface systems, and video technologies.
8. Assessment techniques that involve higher order thinking skills, problem solving and, when relevant, use of manipulables or hands-on materials.
9. Use of a variety of strategies for teaching mathematics and science including inquiry based instruction, cooperative learning, questioning techniques, discussion and presentation strategies, classroom organization and management, motivation, and assessment techniques.
10. Use of strategies found to be effective in engaging female and minority students, especially Native Americans, in mathematics and science coursework.
11. A culture in which teachers' efforts to promote students' involvement in mathematics and science are actively supported by school administrators, parents and other community members.

S.T.E.P. Goals for Preservice Teacher Training

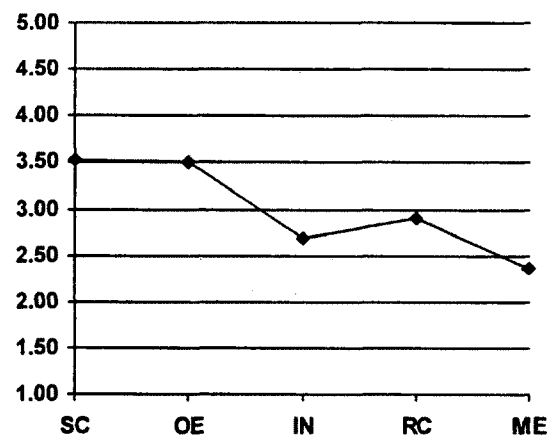
Table 2

Goals for Preservice Teacher Training	
Table 2 (from S.T.E.P.)	
Preservice Supervision at Model Sites	
1.	Preservice teachers are given continuous opportunities to observe and discuss exemplary mathematics and science teaching.
2.	Preservice teachers are given chances to try out their knowledge and skills in a gradual model that begins with relatively simple, low risk assignments with few children and progresses to more complex and extensive assignments with larger groups.
3.	Preservice teachers have regular opportunities for (a) face to face dialogue and feedback with the cooperating teacher and university supervisor, and (b) electronic dialogue with university mentors (including content and education faculty) and with a cohort group of other student teachers.
4.	Cooperating teachers nurture the preservice teachers' abilities to reflect on long term and significant aims of mathematics and science teaching, not just particularistic, daily concerns.
5.	Cooperating teachers assist preservice teachers in practicing various strategies for self evaluation.
6.	Cooperating teachers encourage preservice teachers to view their own development as instructors as a long term proposition, extending well beyond student teaching, and to become active seekers of information about mathematics, science, and pedagogy.
7.	For elementary preservice teachers, field experiences are structured so that sufficient attention is devoted to observing and practicing mathematics and science teaching.
8.	All preservice teachers are assigned to cooperating teachers who are committed to and skilled in teaching math or science (secondary), and both fields (elementary).

Figure 4
SLEI Laboratory Learning Profile

Figure 4

Laboratory Learning Profile from SLEI Data Analysis of Student Cohesiveness, Open Endedness, Topic Integration, Rule Clarity, and Material Environments. Scores above 3.00 indicate positive responses.



Inquiry Quotient Assessment

Criterion	Scale	Score
The Lesson		
1. Material and activities of interest		
2. Materials and activities which provoke thinking, questioning, and discussion		
3. Provision within the lesson for a variety of level and paths of investigation		
4. Content fits intellectual level of learner		
5. Lesson involves fundamental concept of the discipline		
6. Reading does not impede lesson success		
7. Visual aids used as effective supplements		
Student Behavior		
8. Students making observations and collecting data		
9. Students formulating and testing hypothesis, models or predictions		
10. Students analyzing, interpreting and evaluating data		
11. Class conclusions based on evidence		

Criterion	Scale	Score
Teacher Behavior		
12. Is fellow investigator	0 1 2 3 4 No about 50% of time Yes	
13. Acts as a classroom secretary when data need to be organized	0 1 2 3 4 No about 50% of time Yes	
14. Concept introduced after direct experiences	0 1 2 3 4 No about 50% of time Yes	
15. Opportunities for extending concept meaning provided	0 1 2 3 4 concept introduced and not referred to again numerous examples are mentioned and discussed authority additional lessons involve concept to enlarge, refine and reinforce learning	
16. Calmly handles classroom interruptions	0 1 2 3 4 No about 50% of time Yes	
17. Appears confident, calm, friendly	0 1 2 3 4 No about 50% of time Yes	
Questioning Techniques		
18. Majority of teacher questions are divergent	0 1 2 3 4 No about 50% of time Yes	
19. Convergent questions are used effectively	0 1 2 3 4 No about 50% of time Yes	
20. Questions are phrased directly and simply	0 1 2 3 4 No about 50% of time Yes	
21. Individuals called upon after questions asked	0 1 2 3 4 No about 50% of time Yes	
22. Allows sufficient time for student response	0 1 2 3 4 No about 50% of time Yes	
23. Accepts student answers and opinions	0 1 2 3 4 No about 50% of time Yes	
24. Responds to questions by providing additional ideas, information, or clues to extend student thinking	0 1 2 3 4 No about 50% of time Yes	
25. Teacher and students enjoyed the lesson	0 1 2 3 4 No one enjoyed the lesson 50% of the students all students enjoyed the lesson	

SCIENCE LABORATORY ENVIRONMENT INVENTORY (SLEI)**Class Actual Form****Directions**

This questionnaire contains statements about practices which could take place in this laboratory class. You will be asked how often each practice actually takes place.

There are no 'right' or 'wrong' answers. Your opinion is what is wanted.

Please do not write on this questionnaire. All answers should be given on the separate Answer Sheet.

Think about how well each statement describes what your laboratory class is actually like. Draw a circle around

1	if the practice actually takes place	ALMOST NEVER
2	if the practice actually takes place	SELDOM
3	if the practice actually takes place	SOMETIMES
4	if the practice actually takes place	OFTEN
5	if the practice actually takes place	VERY OFTEN

Be sure to give an answer for all questions. If you change your mind about an answer, just cross it out and circle another.

Some statements in this questionnaire are fairly similar to other statements. Don't worry about this. Simply give your opinion about all statements.

Practice Example. Suppose that you were given the statement: "Students choose their partners for laboratory experiments." You would need to decide whether you thought that students actually choose their partners 'Almost Never', 'Seldom', 'Sometimes', 'Often' or 'Very Often'. For example, if you selected 'Very Often', you would circle the number 5 on your Answer Sheet.

Scoring: On the following page, items without their item numbers underlined are scored 1, 2, 3, 4 and 5, respectively, for the responses Almost Never, Seldom, Sometimes, Often and Very Often. Underlined items are scored in the reverse manner. Omitted or invalidly answered items are scored 3.

Social Security Number _____

Remember that you are being asked how often (Almost Never, Seldom, Sometimes, Often, Very Often) that each of the following practices actually takes place in this laboratory class.	Almost Never Seldom Sometimes Often Very Often	For Teacher's Use
1. Students in this laboratory class get along well as a group. 2. There is opportunity for students to pursue their own science interests in this laboratory class. 3. What we do in our regular science class is unrelated to our laboratory work. 4. Our laboratory class has clear rules to guide student activities. 5. The laboratory is crowded when we are doing experiments.	1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5	_____ _____ R _____ _____ R _____
6. Students have little chance to get to know each other in this laboratory class. 7. In this laboratory class, we are required to design our own experiments to solve a given problem. 8. The laboratory work is unrelated to the topics that we are studying in our science class. 9. This laboratory class is rather informal and few rules are imposed. 10. The equipment and materials that students need for laboratory activities are readily available.	1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5	R _____ _____ R _____ R _____ _____
11. Members of this laboratory class help one another. 12. In our laboratory sessions, different students collect different data for the same problem. 13. Our regular science class work is integrated with laboratory activities. 14. Students are required to follow certain rules in the laboratory. 15. Students are ashamed of the appearance of this laboratory.	1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5	_____ _____ _____ _____ R _____
16. Students in this laboratory class get to know each other well. 17. Students are allowed to go beyond the regular laboratory exercise and do some experimenting of their own. 18. We use the theory from our regular science class sessions during laboratory activities. 19. There is a recognized way of doing things safely in this laboratory. 20. Laboratory equipment is in poor working order.	1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5	_____ _____ _____ _____ R _____
21. Students are able to depend on each other for help during laboratory classes. 22. In our laboratory sessions, different students do different experiments. 23. The topics covered in regular science class work are quite different from topics dealt with in laboratory sessions. 24. There are few fixed rules for students to follow in laboratory sessions. 25. The laboratory is hot and stuffy.	1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5	_____ _____ R _____ R _____ R _____
26. It takes a long time to get to know everybody by his/her first name in this laboratory class. 27. In our laboratory sessions, the teacher/instructor decides the best way to carry out the laboratory experiments. 28. What we do in laboratory sessions helps us to understand the theory covered in regular science classes. 29. The teacher/instructor outlines safety precautions before laboratory sessions commence. 30. The laboratory is an attractive place in which to work.	1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5	R _____ R _____ _____ _____ _____
31. Students work cooperatively in laboratory sessions. 32. Students decide the best way to proceed during laboratory experiments. 33. Laboratory work and regular science class work are unrelated. 34. This laboratory class is run under clearer rules than other classes. 35. The laboratory has enough room for individual or group work.	1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5	_____ _____ R _____ _____ _____

For Teacher's Use Only: SC OE ____ I ____ RC ____ ME ____

Environmental Issues Attitude Defensibility Inventory

The purpose of the instrument you are about to take is to look at the decision one makes in the context of an environmental issue. Further, it assesses the information one considers in making that decision.

Directions: You will be presented with an environmental problem in the form of a short narrative. At the end of the narrative you will be asked to make a decision. Please mark your decision (mark one and only one) next to the appropriate number on the answer sheet. Next you are asked to think through what facts, concepts, or alternatives you considered in making that decision. Then you will be presented with a list of 12 considerations. For each of these 12 considerations, indicate the extent to which it entered into your decision by marking the appropriate degree. On your answer sheet use the following scale next to the consideration number:

1. Of great importance to my decision.
2. Of much importance to my decision.
3. Of some importance to my decision.
4. Of little importance to my decision.
5. Of no importance to my decision.

Do not assume that the 12 considerations are, in fact, true. If you believe a consideration is false or not accurate, simply mark '5', "Of no importance to my decision." Please mark the appropriate box on the answer sheet and then on the survey sheet write in your thought(s).

Dr. Benjamin Uiko is chief advisor to the Minister of Agriculture and Human Resources in a developing Asian country. His relatively poor country has both a population problem and an acute food problem. The ministry is seeking a plan that will effectively deal with this whole class of problems (food and population). Currently under consideration is a proposal in which maximum efforts and money would be put into much more farm machinery, new high-yield grains, and fertilizers to increase food productions on the country's marginal farmlands. Dr. Uiko's advice will carry much weight in the final decision.

1. What should Dr. Uiko recommend?

- (1) Enact the plan without reservations.
- (2) Enact the plan with reservations.
- (3) Discard the plan with reservations.
- (4) Discard the plan without reservations.

BEFORE YOU TURN THE PAGE, PLEASE PAUSE AND THINK THROUGH WHAT FACTS, CONCEPTS, AND/OR ALTERNATIVES YOU CONSIDERED IN MAKING THAT DECISION.

Use the following scale to indicate the importance of each consideration to your decision:

- (1) Of great importance to my decision.
- (2) Of much importance to my decision.
- (3) Of some importance to my decision.
- (4) Of little importance to my decision.
- (5) Of no importance to my decision.

Remember, do not assume that the considerations are true. Mark '5' if you believe it to be false or not accurate.

-
- 2. There is an ultimate carrying capacity (even with the most current technology) above which a population cannot be sustained.
 - 3. History shows that following an agricultural revolution, population growth tends to decrease.
 - 4. Starvation is one of the natural "control" methods of regulating human populations.
 - 5. In accordance with increased food, some means of birth control must be enacted.
 - 6. Increased use of fertilizer may increase the rate of eutrophication of the lakes and ponds in the area.
 - 7. A decrease in mortality (reducing starvation by higher food production) can cause sigmoidal population growth toward the carrying capacity.
 - 8. Human population will "turn off" reproduction as a response to crowding much the same as other populations do.
 - 9. Increases in food production will be a temporary effective method for meeting the needs of the people.
 - 10. Improved agricultural techniques will, in effect, increase the carrying capacity of an area and thus feed a bigger population.
 - 11. Increases in human population are primarily a function of decreased mortality rather than increased natality.
 - 12. The nutritional level of the high-yield grains is currently in question.
 - 13. In the 1700's, Malthus presented the theory that unrestricted populations increase geometrically while the food supply increases arithmetically.

Dr. Joan Williams is head of a project to develop a wildlife sanctuary near a large metropolitan area. Included in this 5000 acre preserve is a 75 acre lake. Her objective is "to develop a natural area with a diverse flora and fauna, that will be self-perpetuating." The State Fish and Game Commission has made an offer to introduce 15 species of fish and a concentrated solution of various algae into the lake. Furthermore, they propose to fertilize the lake until "a natural balance" has been reached.

14. What action should Dr. Williams take on this offer?

- (1) Accept the offer without reservation.
- (2) Accept the offer with reservation.
- (3) Reject the offer with reservation.
- (4) Reject the offer without reservation.

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- (5) Of no importance to my decision.

Remember, do not assume that the considerations are true. Mark '5' if you believe it to be false or not accurate.

15. Before such an introduction is made the symbiotic relationships among the total proposed community must be understood.
16. The present algae levels may be sufficient to sustain a well balanced fish community.
17. All fish are not algae eaters.
18. Fertilization of the lake may increase the frequency and intensity of algae "blooms".
19. Fertilization of the lake creates an "artificial" production that may effect the carrying capacity of the lake, but when removed would cause population crashes.
20. The physical features, such as depth and temperature, as well as biological features of the lake must be explored.
21. Communities are built on delicate balances and the addition or removal of species may effect the stability.
22. Intermediate steps in the food chain (herbivores and primary carnivores) must be considered along with the productivity of the producers.
23. This introduction would produce "instant" diversity regardless of the present species composition.
24. Species introduction may cause the extinction of desirable species already present.
25. A diverse well balanced population may already exist in the lake.
26. One needs to know if the 15 species were at one time natural inhabitants of the lake.

Dr. James Okonkow is the chief agricultural and environmental agent for a small province of a central African country. There is no famine in this small soil rich country. Dr. Okonkow is proud of the agricultural production and at the same time he loves the water fowl and the cichlid fishes that inhabit the large lake in the center of the province wide drainage basin. Recently, in an attempt to advance their wheat and corn production, the farmers have petitioned to use DDD, an insecticide very similar to DDT, in a war against insect pests. The resulting increased production, they claim, could allow them to export agricultural goods for the first time in their history. The decision belongs to Dr. Okonkow as chief agricultural and environmental agent.

27. What should he do regarding the use of DDD?

- (1) Authorize use without reservation.
- (2) Authorize use with reservation.
- (3) Deny use with reservation.
- (4) Deny use without reservation.

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- (5) Of no importance to my decision.

Remember, do not assume that the considerations are true. Mark '5' if you believe it to be false or not accurate.

-
28. Many crops can show a 20 fold increase in yield with the use of insecticides.
 29. DDT residues have been found in human milk.
 30. Natural non-persistent sprays, although not as effective, can be obtained from plants with natural resistance to insects.
 31. DDT is not readily "broken-down" and therefore tends to accumulate and even "migrate" in the ecosystem.
 32. Thousands of non-target insects will be killed, many of which may be predators on the insect pests.
 33. A nearly insect free product can be produced with the use of insecticides.
 34. In large fields effective use can be made of natural insect controls in the form of parasites and predators.
 35. Insects over generations have built up resistance to sprays, requiring higher concentrations to be effective.
 36. Antidotal chemicals exist to counteract the effects of DDT in wildlife areas.
 37. Levels of DDT tend to accumulate in the bodies of organisms higher in the food chain.
 38. Development of non-agri-industry would in the long run be more destructive to the environment than the use of pesticides.
 39. The presence of DDT in eggs of birds decreases their hatchability.

Dr. Alexi Pokrovsky is the head of regional planning in the Ukraine area of the Soviet Union. A wilderness lake several hundred miles long and about fifty miles wide is located in his district. Averaging approximately 30 meters in depth, it is very similar in geomorphology to Lake Erie. At the present time there is an abundance of high quality fish. This lake is being considered for the development of an experimental nearly self-sufficient urban area. This plan includes using the rich upstream area for industrial farming, exploration of the fishing industry and also urbanization of the southern shore. The plan would be of obvious economic benefit to the area, but Dr. Pokrovsky is also concerned with the effect on the lake.

40. What action should Dr. Pokrovsky take?

- (1) Enact plan without reservation.
- (2) Enact plan with reservation.
- (3) Discard plan with reservation.
- (4) Discard plan without reservation.

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Remember, do not assume that the considerations are true. Mark '5' if you believe it to be false or not accurate.

-
41. Fertilizer from the farming operation would artificially add nutrients to the lake and increase the rate of eutrophication.
 42. Temperature increases could contribute to an increase in oxygen levels.
 43. The long term succession of a lake will lead to a filling in of the basin by continual siltation.
 44. Phytoplankton "blooms" tend to deplete the oxygen levels.
 45. A lake this size has the power to cleanse itself and, therefore, man can have only minimal effect on it.
 46. Engineering procedures exist whereby sludge can be removed, benthic fauna can be cleansed, toxins can be precipitated out of the ecosystem; and all at a reasonable expense.
 47. Domestic sewage can artificially add nutrients to the lake and increase the rate of eutrophication.
 48. Toxins which may be introduced as industrial waste can accumulate in the food chain.
 49. Domestic sewage can increase the bacterial levels in the lake.
 50. Eutrophication is a slow natural process where nutrients increase and change the character of the ecosystem of a lake.
 51. Over-fishing could "cause" a shift in the abundance of desirable fish because of the increase pressure of an effective predator -- man.
 52. Location of the farms in a down-stream area could lessen the effects on the lake.